development and, by complete absorption, leave no trace in the fully mature grain. For the determination of this point the following forms were examined: *Cupressus* (four species), *Taxus baccata* and four varieties, *Juniperus* (two species), *Chamæcyparis* (five species), *Callitris* (one species), *Cryptomeria japonica, Thuja orientalis.*

The results showed that in all these forms there was no prothallial cell formed at any time in the development of the pollen. Ovules of *Thuja orientalis* and *Taxus baccata* were examined to determine the number of potential megaspores formed. It was found that in *Taxus* there are four produced—these lying, as a rule, in a row, and the lower developing into the prothallium.

In *Thuja* there are also four magaspores produced, but they are arranged, not in a row, but in nearly regular tetrad form, differing in this respect from all other gymnosperms so far studied.

W. F. GANONG,
Secretary.

SMITH COLLEGE,
NORTHAMPTON, MASS.

SCIENTIFIC BOOKS.

STILL ANOTHER MEMOIR ON PALÆOSPONDYLUS.

Palæospondylus, like Gloster, seems to have been born to bite the world—for in its few short years of morphological nurture it has succeeded in causing trouble to an amazing degree. And we venture to use an Elizabethan simile with a clearer conscience, since in the latest time we are told that this obscure little fossil is not to be looked upon as a toothless lamprey, but rather as a shark. We must none the less admit that it gives us a sense of sadness to learn of the new rôle of the fish, since this reduces by one the novelty of its being assigned to still other groups, for we recall that the number of groups is well nigh exhausted. There remains in fact but one more of the major groups of aquatic vertebrates to which it can possibly be assigned. It has already been reckoned among arthrodires (? ostracophores), lampreys, teleostomes (*Allis*), sharks, lung-fishes, even amphibians. To make our list complete, we have now only to assign it to holocephals. And lest some one anticipate us, we may as well regard it as a chimæroid at this time, and in evidence of this refer to its continuous dorsal fin, 'protocercal' tail, ring vertebræ, elaborate nasal cartilages, huge head—and we might find other similarities if we tried hard enough. Seriously, though, such a state of affairs is a reproach to modern morphology, that with all our extensive knowledge of fishes we are not able to come to a better understanding of our Devonian 'lamprey.' For if the remains of *Palæospondylus* are so poorly preserved that they cannot be definitely described, why do we continue to add papers to the troublesome literature? The only possible excuse is that the creature is seductive, full of suggestions as to the origin of the gnathostomes, and the mode of evolution of jawless vertebrates.

During the past summer I happened to see in South Kensington some of the elaborate models of *Palæospondylus* which Professor Sollas and Ingerna B. J. Sollas have been preparing. These are built up of thin wax plates, after the method of Born, the sections, however, having been outlined at a series of levels (differing in thickness for about .1 +, .025 mm.) as the fossil was carefully ground down. And I examined the models with great interest, wondering whether by a new method there could be gained facts which would help to solve the present puzzle.

In their complete paper* the authors now discuss the results obtained from a series of their models, of which no less than eight have been prepared. They describe the characteristic parts of the fossil, christening some of them with rather difficult names such as 'hemidome,' 'tauidion,' 'ampyx,' 'gammation' and 'pre-gammation.' But the structures described which interest us especially are the 'branchial arches,' four in number, showing

* 'An Account of the Devonian Fish, *Palæospondylus gunni*, Traquair,' by W. J. Sollas and Ingerna B. J. Sollas, *Phil. Trans.*, Series B, Vol. 196, pp. 267–294, pls. 16 and 17.

both 'epi-' and 'basi-' and 'cerato-branchial' divisions, and the 'quasi-maxillary' cartilage. For if these structures are present, our knowledge of *Palæospondylus* has made a forward step and an important one. For it excludes one hypothesis, that of a Devonian lamprey. I confess, however, much as I am in sympathy with this result, that a critical examination of the present plates does not convince me that the authors have carried their point. When one bears in mind the fact that the head region of the tiny fossil is flattened out of reason, bitumenized, with parts displaced, with irregular contours now separate, now confluent, it is difficult to see, for example, why the 'maxillaries' should be anything more than the rim of the 'hemidome' (cf. Figs. 10, 11, 12), or the most conspicuous 'gill arches' more than the anterior and posterior rims of the 'otic' mass. And there is in fact variation enough in these elements, even in the figures given, to warrant our skepticism. Indeed, if one has still any faith in the preservation of intricate interrelationships of delicate elements in *Palæospondylus,* he has only, I believe, to consider the shapeless condition of the neighboring vertebral column and fin supports as shown in any of the models, for we are morally sure that centra and fin rays never existed in the living animal in such an amorphous mass as here represented.

Grateful we certainly are to these painstaking authors, for the facts they present are desirable, even though we may be disappointed in their content. But the chiefest virtue of their research is to my mind this—that by the micro-section method we can add little of importance to our knowledge of this form. For in spite of such a method, and admirably carried out, no certain details have been added to those already detected in the usual way by the keen eye of Dr. Traquair. And if this is true one need hardly add that what is especially needed in our future dealings with *Palæospondylus* is less memoir and more material. In this regard I can not repress the belief that the paleontologist who will spend some time, possibly months, in the little quarry at Achanarras will yet solve the puzzle. There is certainly evidence that although five out of ten of the fossils measure between 20 and 30 mm. some certainly occur which are over 50 mm. in length, and that between the largest and the smallest there are gradations in the proportions of head and column both in length and thickness. And if this be true, why may not *Palæospondylus* prove a larval form, and in this event more abundant material might reasonably prove what the adult is? The latest authors 'far from deny that some change in the proportional size of the organs of *Palæospondylus* has taken place with growth,' but I think they would have been more impressed had they examined better preserved specimens, and those especially with a greater range in size. Their smallest specimen probably measured little under 18 mm., for it measured 14 mm. and lacked obviously the tail tip. On the latest evidence, therefore, we can hardly deny the possibility that *Palæospondylus* was a larval form.

Bashford Dean.
Columbia University.

Catalogue of Keyboard Musical Instruments in the Crosby Brown Collection, 1903. The Metropolitan Museum of Art. New York. 4to. Pp. 313. Price, $1.00; express, 25 cents.

In continuation of the series of catalogues already noticed in Science (N. S., XV., p. 943, 1902) the present sumptuous volume has recently been published.

In 127 half-tone plates made from photographs from the originals, 84 keyboard instruments are shown. No such collection of instruments is found elsewhere in the world, and no such collection of illustrations is available in any other book, or dozen books. There are 43 plates of 24 plucked instruments—psaltery, spinet and harpsichord; 47 plates of the 32 instruments with struck strings—dulcimer, clavichord and piano; 2 plates of bowed instruments; 28 plates of the 21 keyboard wind instruments—regals and organs; and 7 plates of 5 pianos with metal or glass bars; then follow 7 plates illustrating actions. Many of them are full-page plates. There is a brief description of each instrument, and the late A. J. Hipkins (remembered by physicists as associated with A. J. Ellis in some of his important work on scales) has furnished a valuable short introduction which points out

the relation of the more important specimens to the development of the art. Where the history or authenticity of a certain instrument is of importance the evidence bearing on these points is furnished. No expense has been spared in bringing out the volume, for its preparation is stated to have cost over two thousand dollars.

But unfortunately the work leaves something to be desired. Generally the instruments were placed for photographing in position to show the whole to the best advantage, and especially any ornamental features. This procedure has two disadvantages; the figures being in photographic perspective, they are much distorted and can not be scaled; and while the general appearance of an instrument is well shown, the details that interest the student can rarely be made out. Views taken in different positions diminish somewhat this disadvantage, and the excellent plate XXVIII. of the clavichord action is a notable exception to the general criticism. A useful addition to the descriptions would have been statements of the vibrating lengths of strings, say for all the C's in the principal instruments, and the striking point; also the diameters of the wires where these appear to be the original ones. Almost any details of construction would be welcome, since they are not easily obtained by the student and yet are of great significance in the technical development of the piano. The few cuts of actions are very unsatisfactory; apparently the draftsman was not familiar with mechanism or mechanical drawing, so some of the figures are misleading or unintelligible.

This catalogue, however, in spite of any defects, is a very valuable addition to the small collection of books that illustrate the predecessors of the modern piano, and nothing else can fill its place. CHARLES K. WEAD.

SCIENTIFIC JOURNALS AND ARTICLES.

IN the *Botanical Gazette* for February Mr. Francis Darwin describes a method of studying the movements of stomata, which depends on the fact that when widely open the stomata permit more rapid evaporation than when closed, the leaves becoming correspondingly cooler. The differences of temperature are measured by a Callendar recorder, in which the difference between the temperatures of two fine platinum wires is recorded on the revolving drum. He describes the apparatus and the various tests that were made to discover the errors and limitations of the method.—G. M. Holferty has investigated the development of the archegonium of *Mnium* and reports that a two-celled apical cell is organized by the archegonium initial, that this later gives place to a three-sided one which is truncate, that this terminal cell gives rise to the first cell of the canal row and also contributes to the growth of the neck, that the terminal cell contributes to the growth of the axial row by the addition of cells cut from its truncate face, and that growth in length of the archegonium neck is intercalary as well as apical in both the neck and canal rows. Unusual conditions were found in which the canal series is double for a greater or less distance, in which the venter contains two eggs and two ventral canal cells, in which there was a double venter with two eggs, and one in which a mass of sperm mother cells was developing in the pedicel tissues of the archegonium. Conclusions are drawn that archegonia and antheridia are homologous structures throughout, and that they probably had a common origin from an isogamous gametangium, which in turn was derived from a multilocular sporangium.—Charles E. Lewis, in studies of certain anomalous dicotyledons (*Podophyllum, Jeffersonia* and *Caulophyllum*), finds small embryos surrounded by an abundant endosperm, and a cotyledonar primordium consisting of a broad ridge-like structure opening at one side, the ridge later bifurcating to form the two lobes known as the cotyledons.—F. A. Shriner and E. B. Copeland give definite data in reference to the relation between deforestation and creek flow about Monroe, Wisconsin. —Laetitia M. Snow publishes a preliminary notice of results in the investigation of the effects of external agents on the production of root hairs, showing that there is a relation between the production of root hairs and the elongation of the roots. The same causes which control growth determine the formation